Optimization of the network design of a futuristic transport system based on accelerated moving walkways

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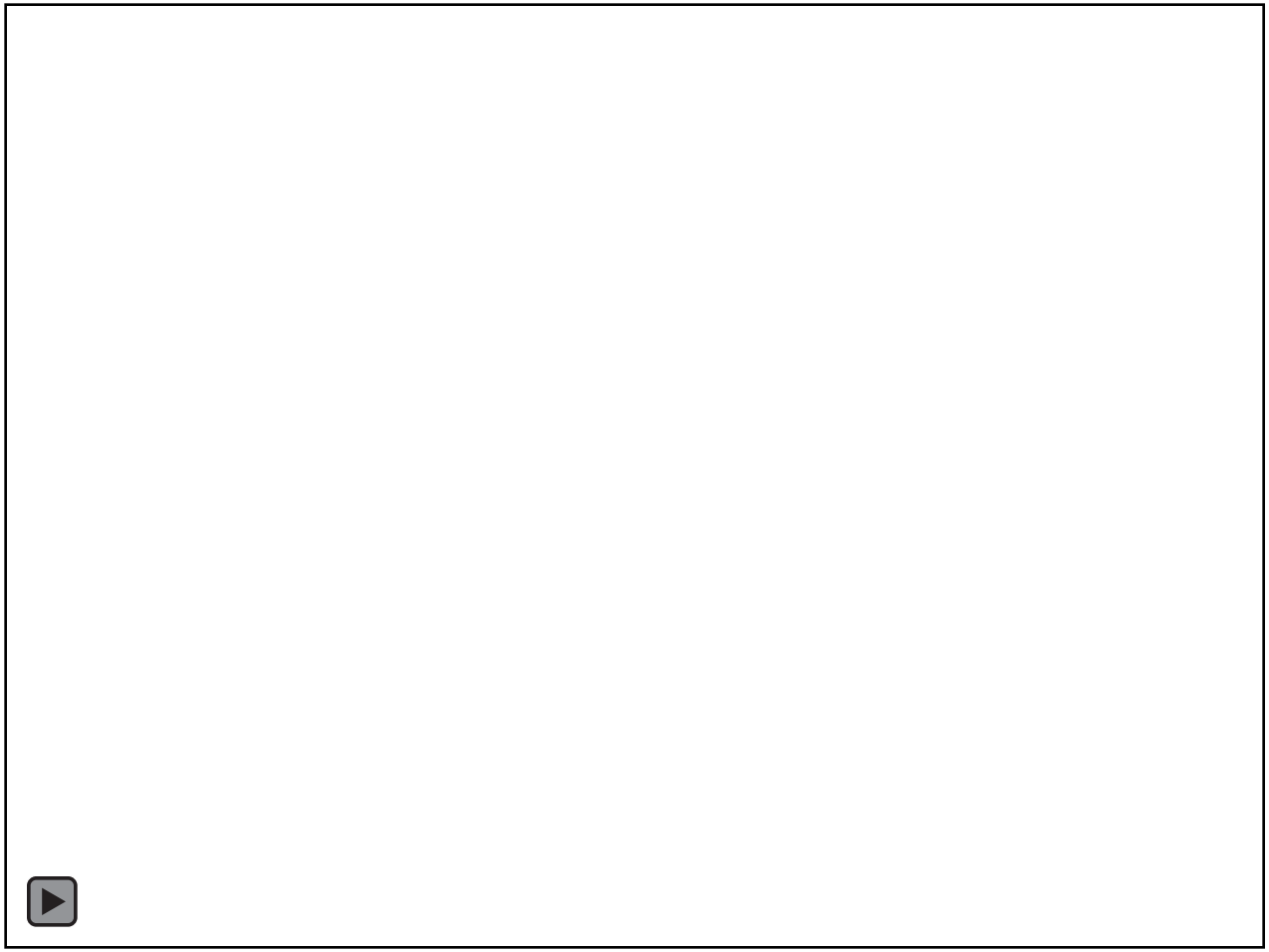
Moving walkway, Exposition Universelle, Paris 1900



Post-Car World

No use of private car

- Redistribute the “future” demand on a mix of transport systems

Traditional

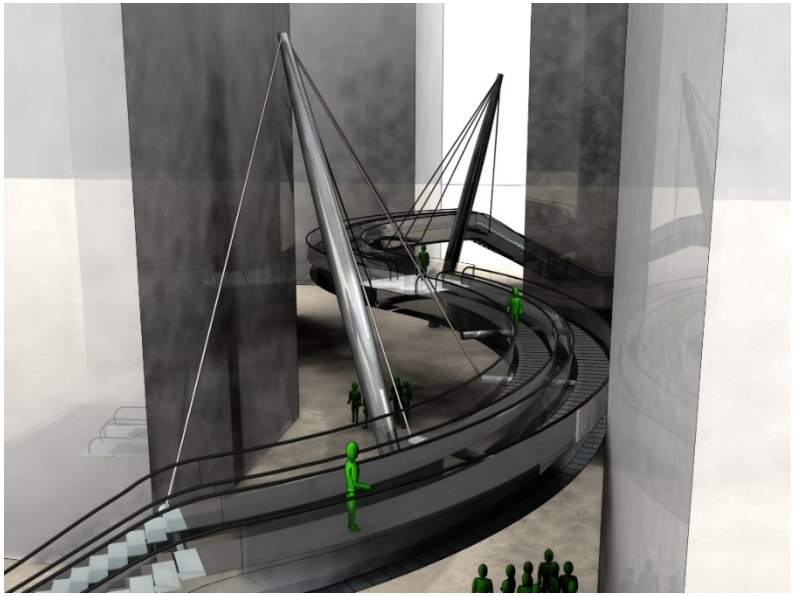
Innovative

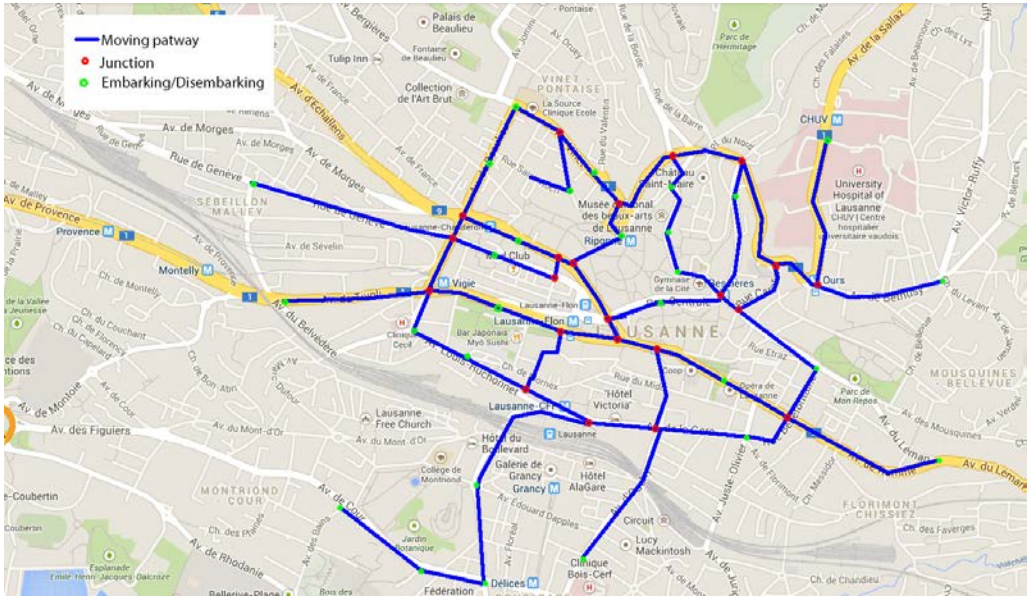
Futuristic

Research idea

Accelerated Moving Walkway (AMW)

A network of Accelerated Moving Walkway in urban area





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- Accelerated Moving Walkway (AMW)
  - Implementation examples
  - System description
- Optimization of a network of AMW
  - Decision variables
  - System parameters
  - Objective function and constraints
- Results
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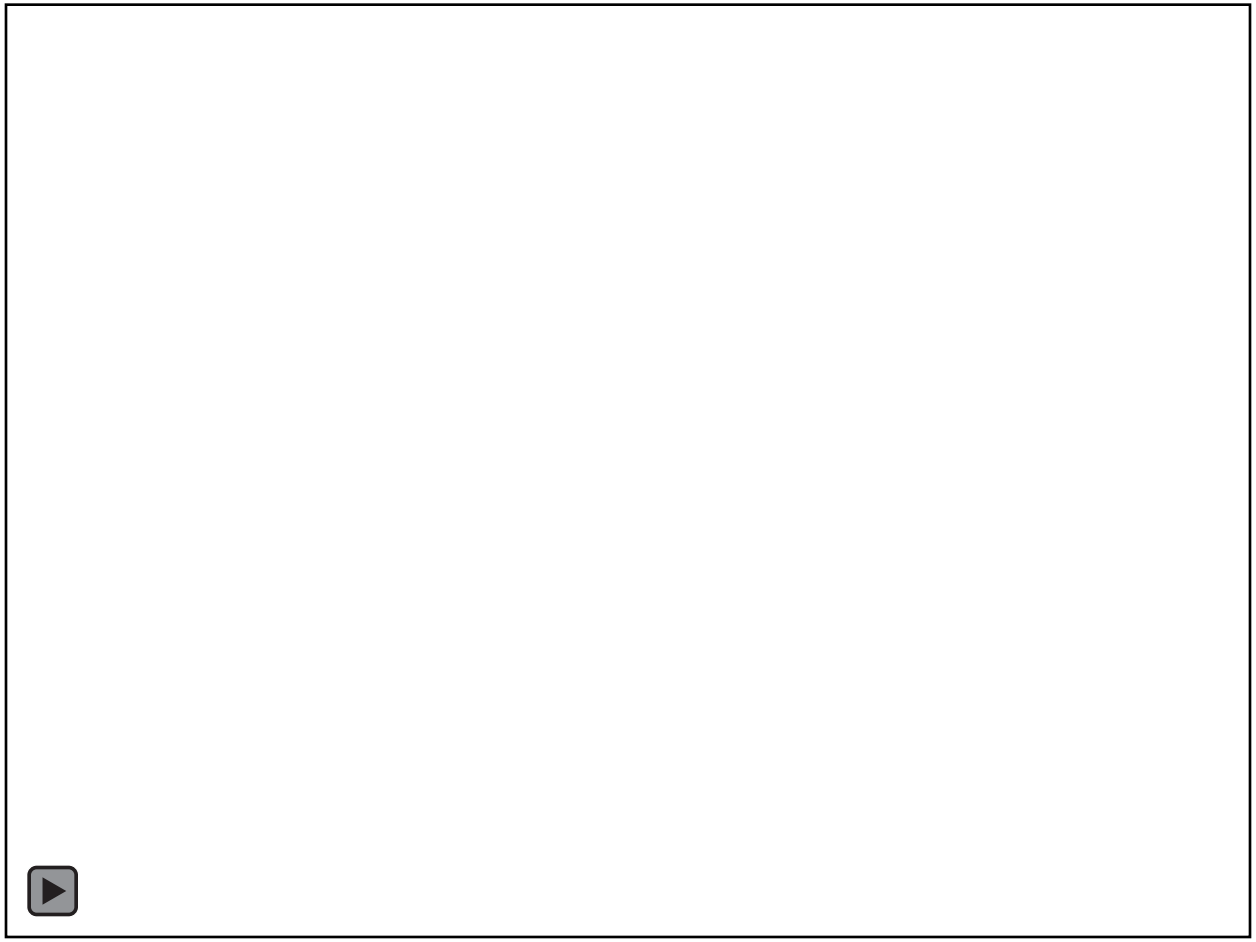
Accelerated Moving Walkway

Accelerated Moving Walkway



Implementation examples

TurboTrack Toronto

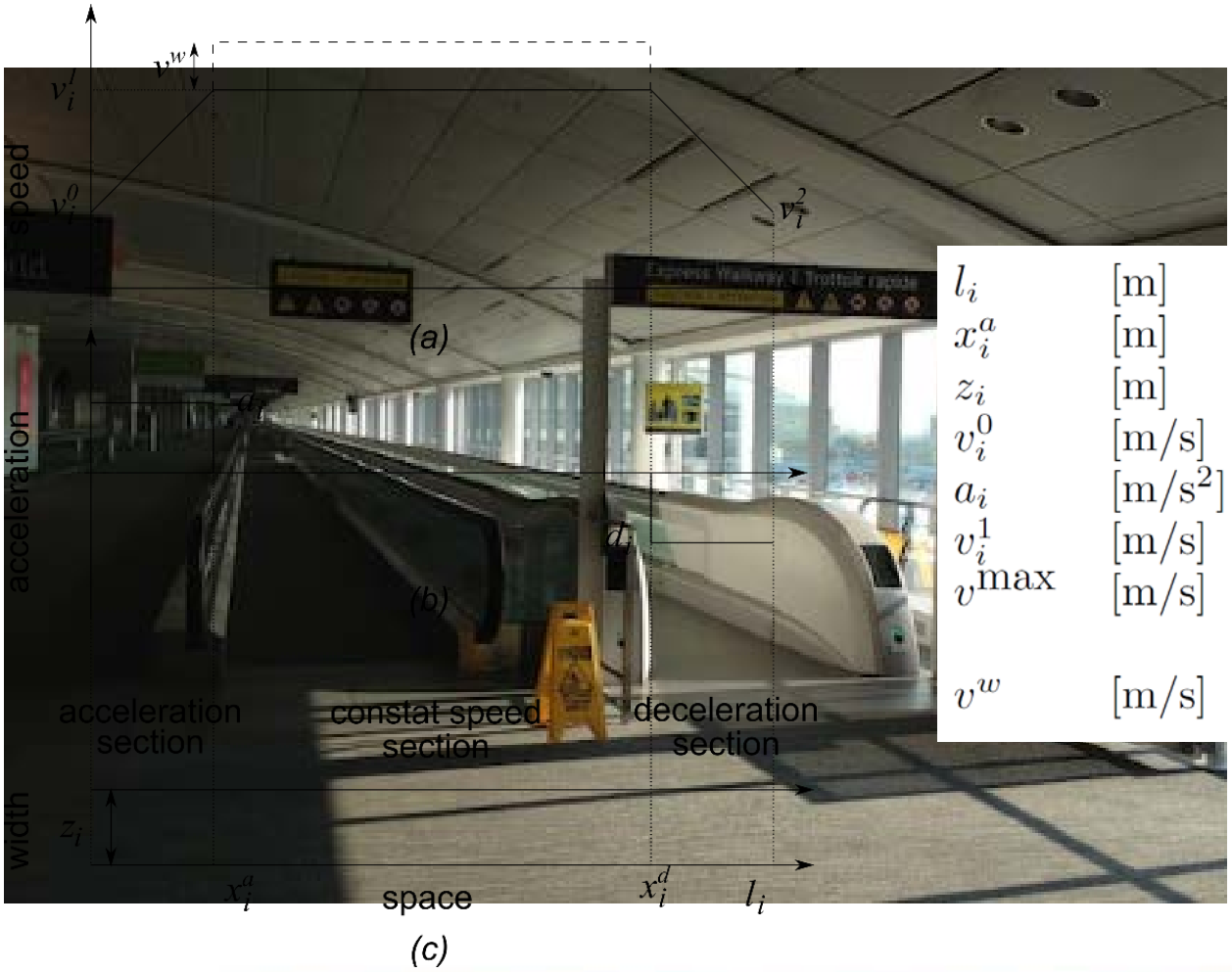
- Entry speed: 2.3 km/h
- High speed: 7.2 km/h
- Length: 270 m

Gateway Paris

- Entry speed: 2.2 km/h
- High speed: 9 km/h
- Length: 185 m

AMW could be competitive with urban public transport and private cars (average speed of 15 km/h)

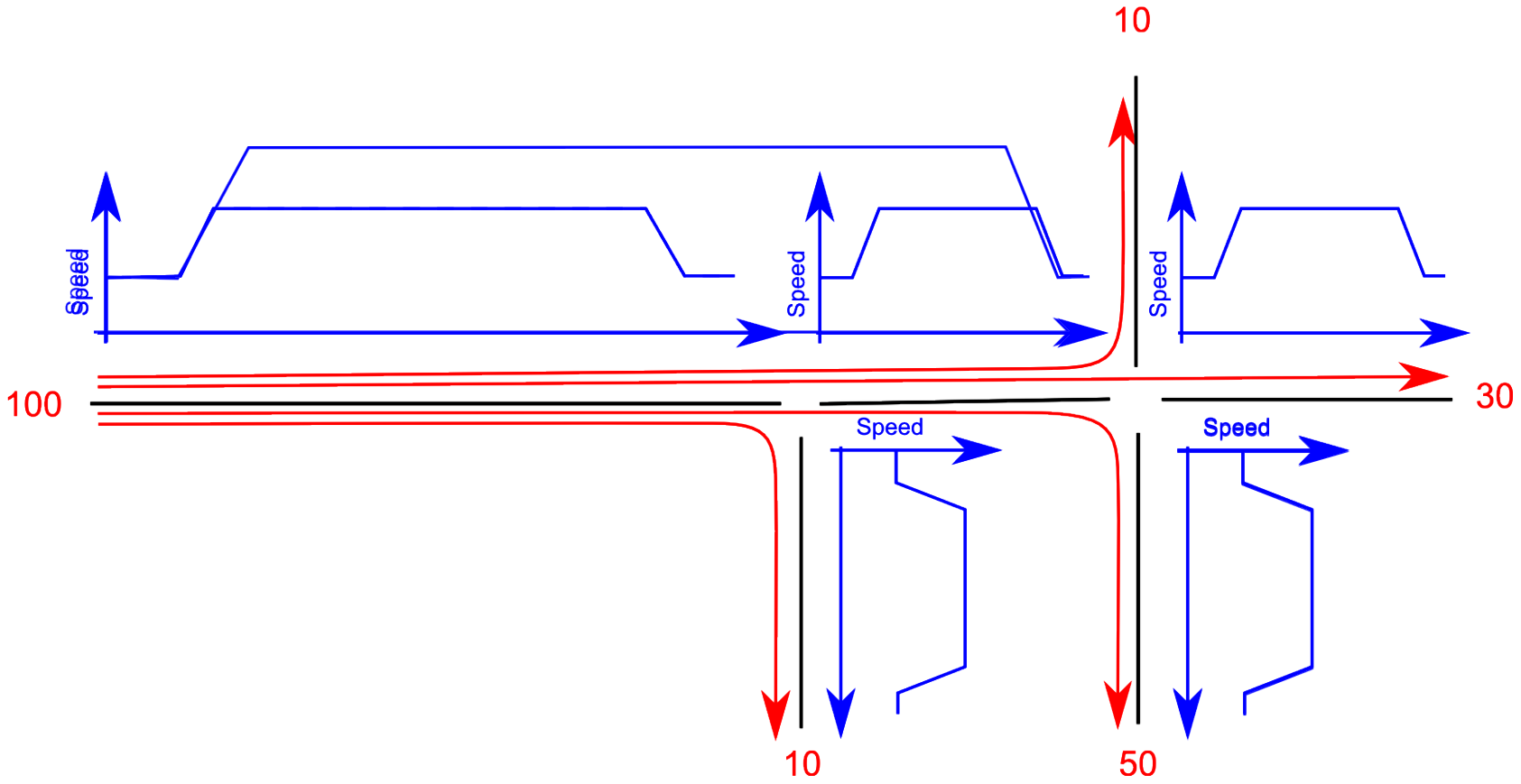
System description in a quantitative form



l_i	[m]
x_i^a	[m]
z_i	[m]
v_i^0	[m/s]
a_i	[m/s^2]
v_i^1	[m/s]
$v^{\max}$	[m/s]
v^w	[m/s]

Optimization of a network of AMW

Conceptual example

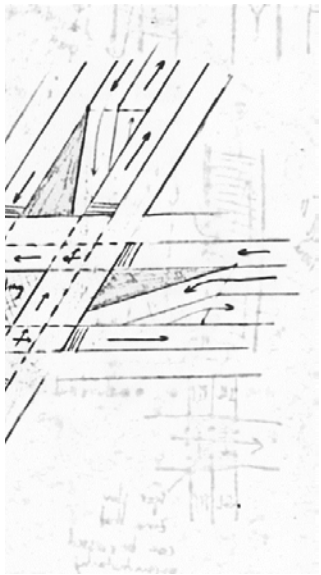


Intersection design

Practicality

Preferred directions

Permeability
Urban integration
Accessibility
Perception
etc..



Images: Rojanawisut

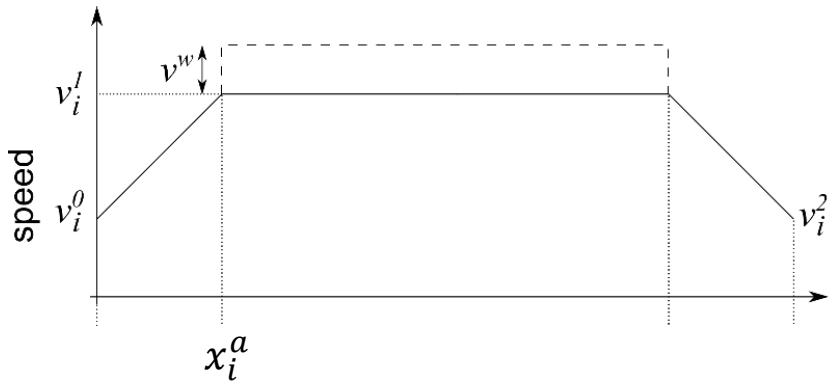
Decision variables and criteria

Decision variables:

- y_i equipped or not
- x_i^a acceleration section
- z_i width of the walkway

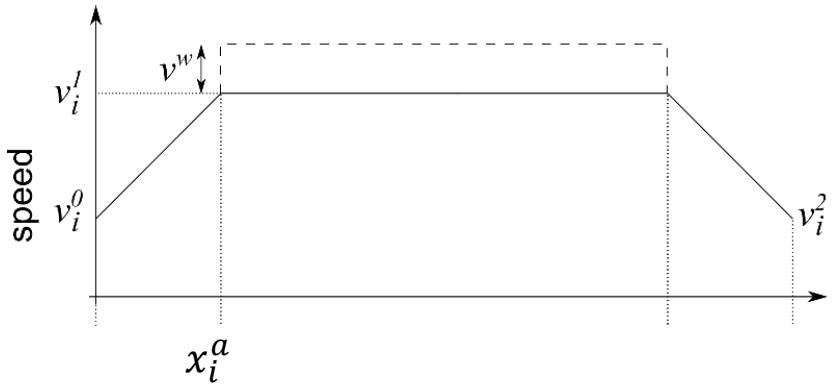
Objectives:

- Min. travel time
- Max. speed
- Max. comfort
- Min. energy consumption



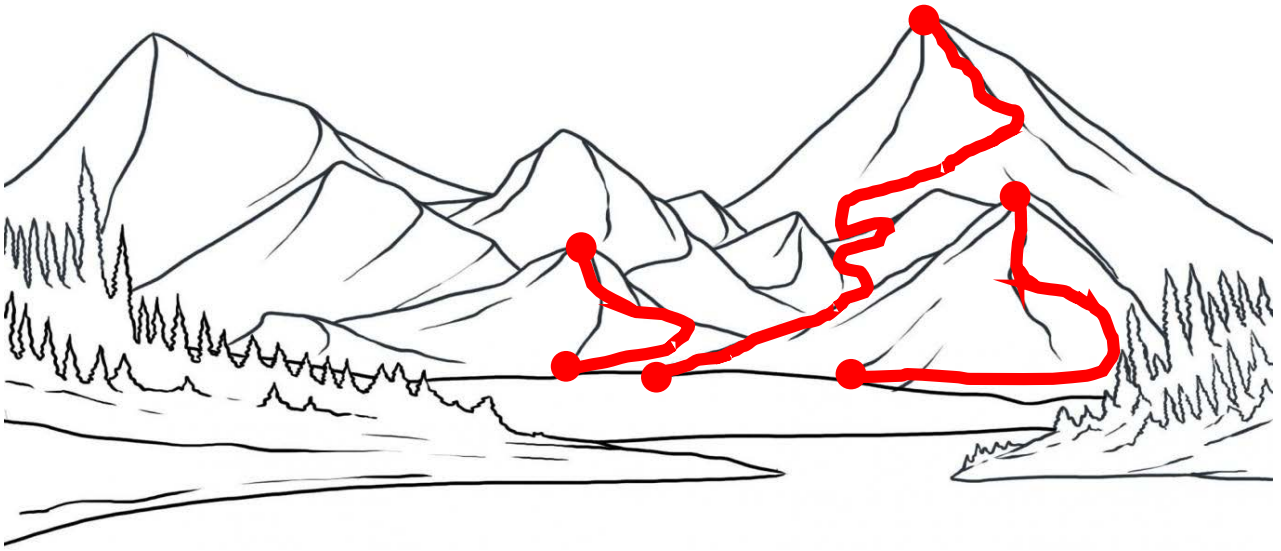
Criteria – mathematical formulation example

- Travel time $$TT_i = 2t_a + t_c = \frac{1}{a}\left(\sqrt{v_0^2 + 2ax_i^a} - v_0\right) + \frac{l_i - 2x_i^a}{\sqrt{v_0^2 + 2ax_i^a} + v^w}$$



Optimization concept

Locate the highest top while blindfolded.



Space: all possible configurations of AMW network

Elevation: objective, i.e. max speed

Objective function

Objective function:

$$f_i = y_i(w_1 TT_i + w_2 d_i + w_3 e_i + w_4 c_i^c + w_5 c_i^o) + (1 - y_i) w_6 l_i / v^w$$

Subject to constraints:

$$v_i^1 \leq v^{\max} \qquad \sqrt{v_0^2 + 2a x_i^a} \leq v^{\max} \qquad x_i^a \leq l_i/2$$

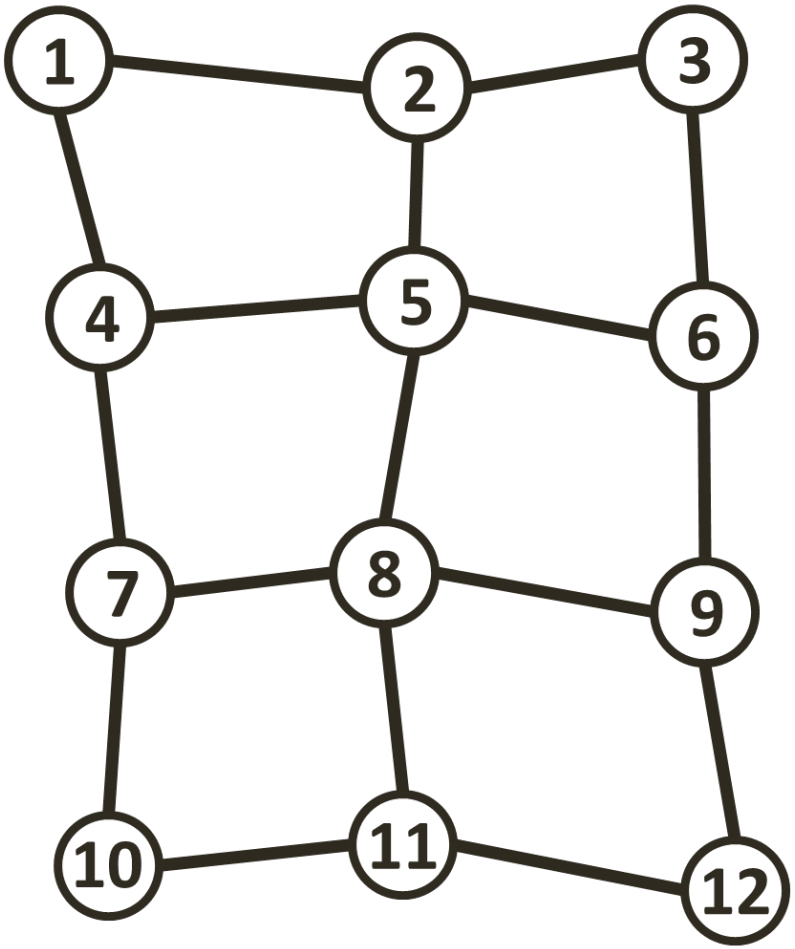
Results

Results

City network

Nodes

Links

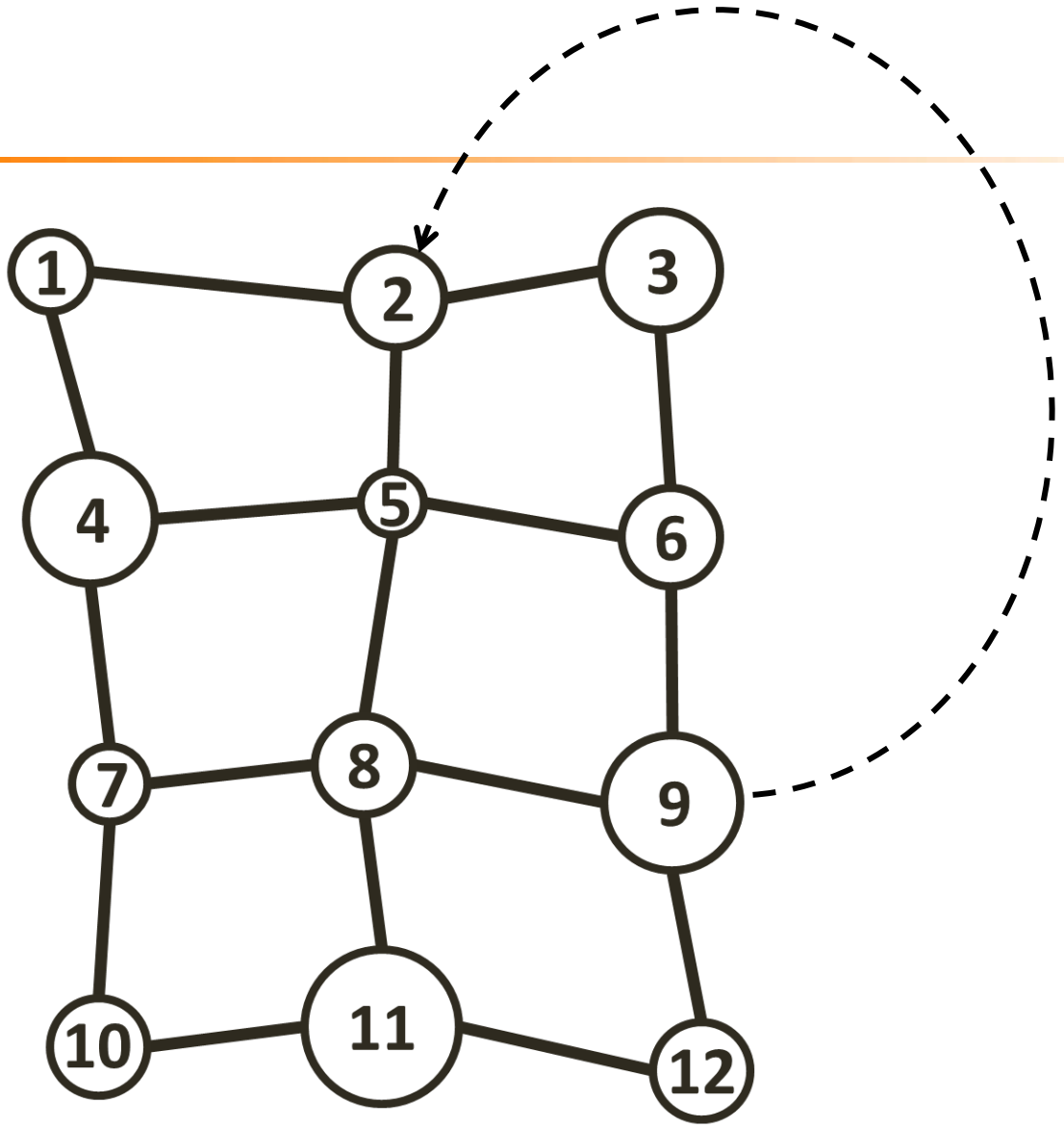


Results

City network

Origin

Destination



Optimization algorithm

Objective:

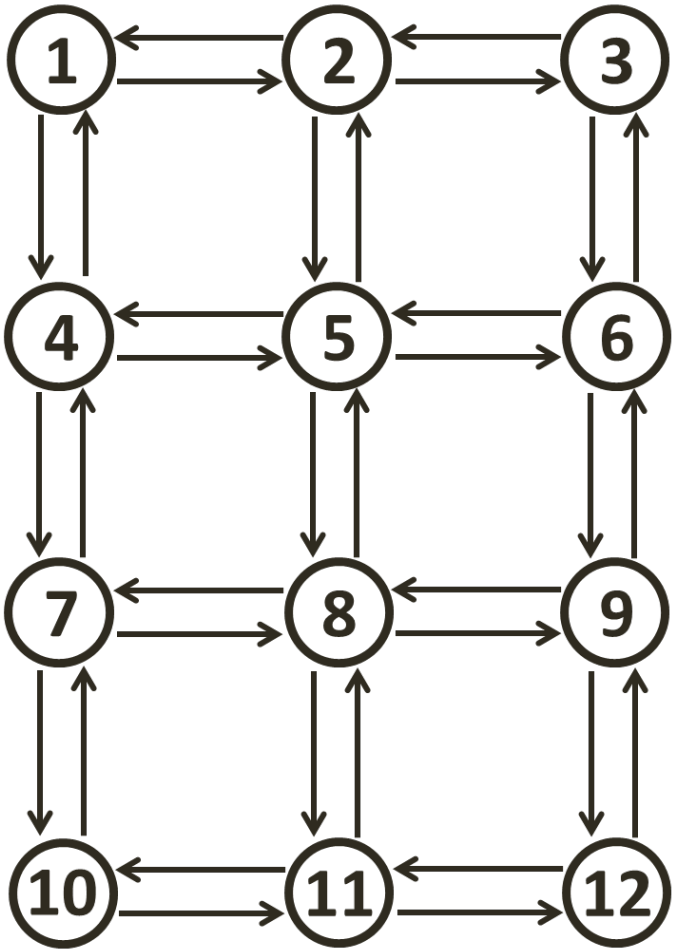
Min. Total

Travel Time

Constraint:

Budged for

10 AMW



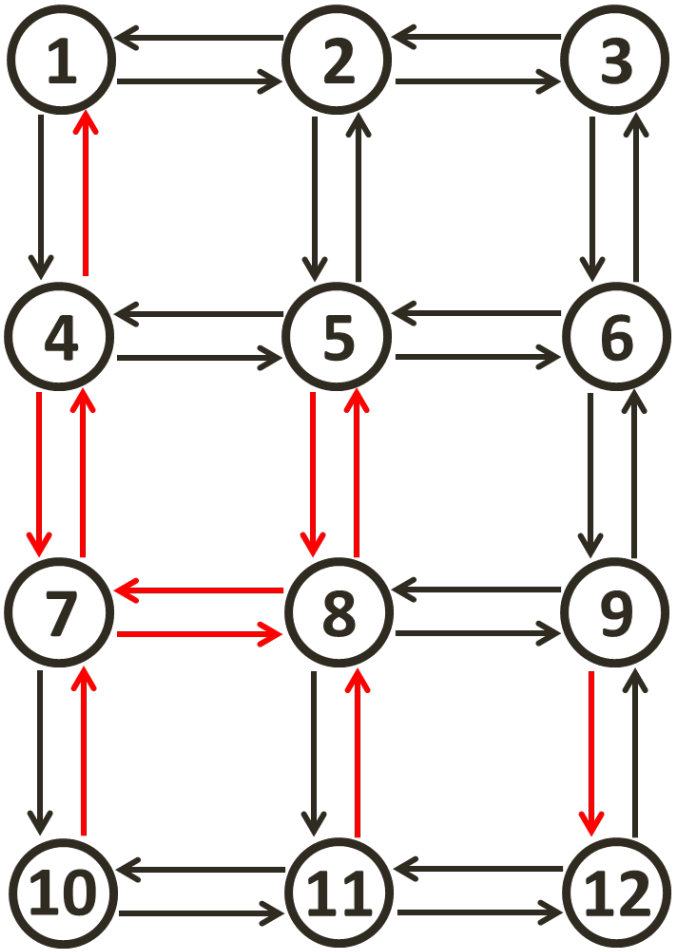
Optimization algorithm

Initial solution

Assignment

- O/D
- Path
- Flow

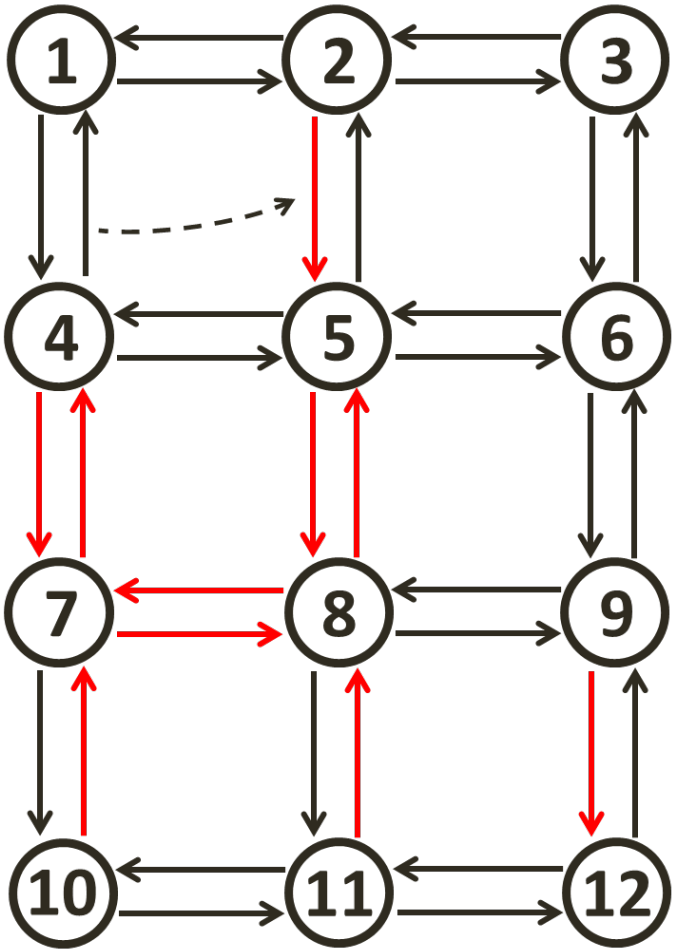
Objective evaluation



Optimization algorithm

Intelligent searching algorithm

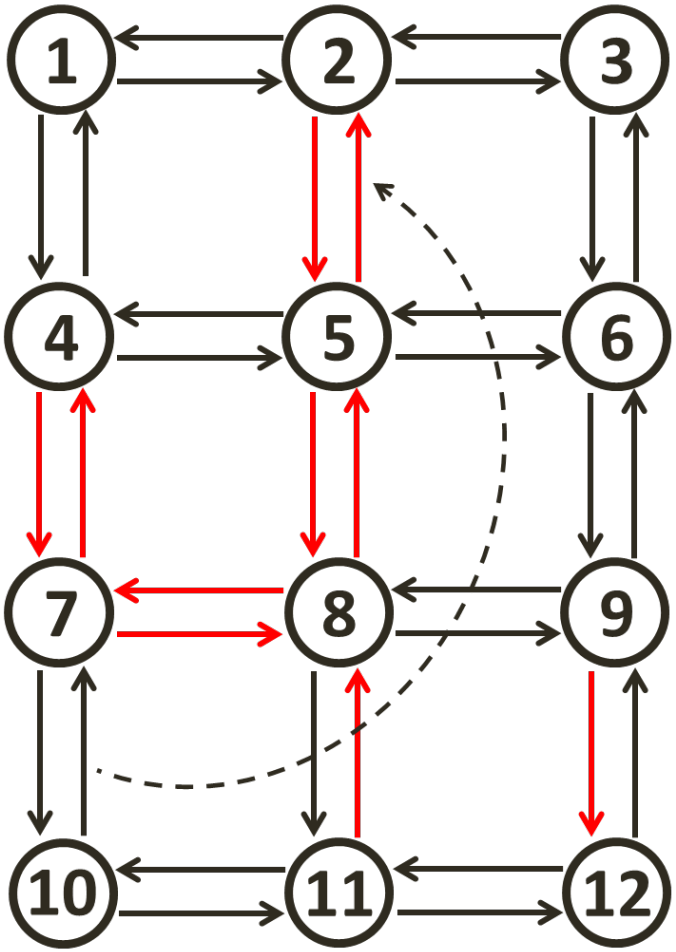
2nd iteration



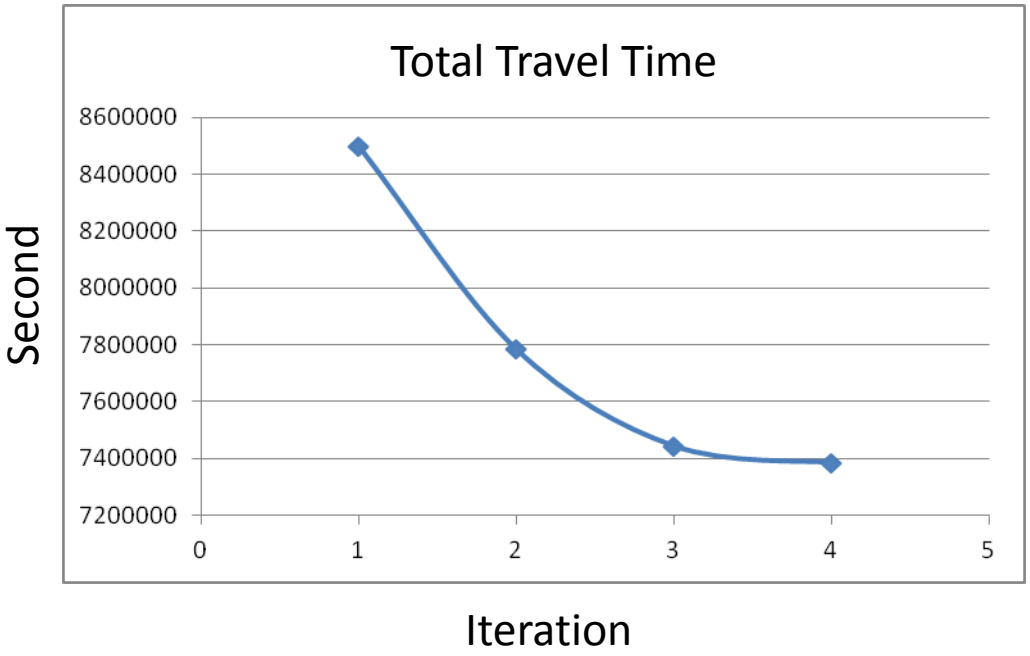
Optimization algorithm

3rd iteration

Convergence



Optimization algorithm



Conclusions

Conclusions

Assumption: a world without private cars

free to investigate innovative mean of transport as part of the future modal mix (reusing urban space)

- Review of Accelerated Moving Walkway (AMW)
- Definition of the optimization problem, decision variables, system parameters, objective function and constraints
- Investigation on the practicality of this system from a transportation point of view

Thank you for your attention

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